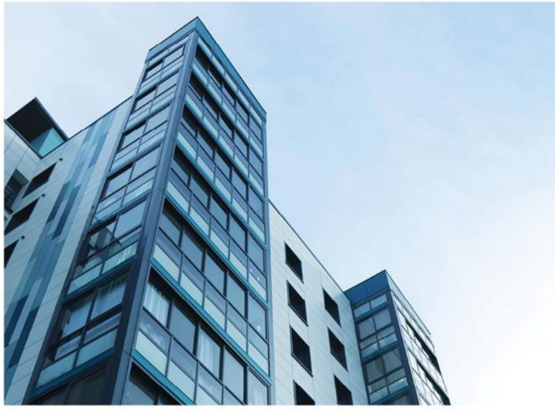

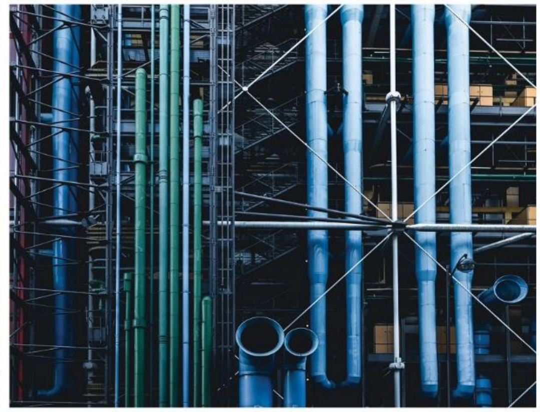

2019 Consolidated Demand Demonstration Project Evaluation Report

prepared for

Eversource

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2019 Consolidated Demand Demonstration Project Evaluation Report

1 Executive Summary

Eversource contracted ERS and DNV GL to evaluate a demand demonstration project that consists of the deployment of four technologies through seven vendors over the span of two years.[1] The four technologies deployed and evaluated include the following:

- **Manual curtailment** – This is a process more than a technology solution. The vendor signals customers to reduce load and the customer can take any steps they choose to make reductions. The equipment types most often controlled are lighting, HVAC (especially air handlers), and industrial process equipment.
- **BMS controls** – Vendors and customers program automated responses to calls for load reduction into the facility building management system (BMS).
- **Thermal storage** – There are two thermal storage solutions. One solution employs packaged HVAC ice storage. The system makes ice at night and thaws it to provide air conditioning during peak hours. The second solution is the combination of adding thermal mass in refrigerated storage warehouse space with controls to reduce compressor usage during peak hours.
- **Battery storage** – Lithium ion batteries are discharged during peak hours.

Through this evaluation, ERS and DNV GL are seeking to help Eversource understand the following: the impacts on summer and winter peak consumption, customer acceptance of the various solutions, barriers and drivers to program implementation, and the ability of the demand demonstration projects to complement efficiency programs, among other topics. The understanding captured in this study will be considered in the development of future demand reduction strategies and programs. Economic evaluation is not in the scope of this study.

The demand demonstration projects were deployed for the 2018 and 2019 summer seasons and 2018–2019 winter season. This combined process and impact evaluation report summarizes the findings from the 2018-2019 winter season and 2019 summer season. Eversource is also administering a pay-for-performance full-scale active demand reduction initiative that was evaluated and reported on separately.

[1] One of the seven vendors implemented a daily dispatch battery solution, which was studied and reported on separately. A small business thermostat program was also the subject of a separate study.

Table 1-1 summarizes the project information and savings summary for each vendor. Table 1-2 summarizes the solutions and their respective dispatch strategies.

Table 1-1. Summary of Solutions

Metric	Vendor Number					
	1	2	3	4	5	6
Technology	Thermal storage	Thermal storage	Targeted Batteries	Manual curtailment	BMS controls	BMS controls
Targeted customer type	C&I facilities with small and medium HVAC units	Cold storage facilities	Medium and large C&I	Large C&I	Large C&I	Large C&I
Season	Summer	Summer	Summer and winter	Summer and winter	Summer	Summer
Frequency of dispatch	Daily	Daily	Targeted	Targeted	Targeted	Targeted
Year 2 summer kW goal	502	1,546	1,250	7,000	5,500	1,100
Reported year 2 summer kW reduction	241	1,110	105	7,204	666[a]	0
Evaluated year 2 summer kW reduction	62	516	105	7,190	28[b]	0
Evaluated summer system peak hour (ICAP) kW reduction	86	577	108	7,914	0	0
Reported winter kW reduction	N/A	N/A	90	6,635	N/A	N/A
Evaluated winter kW reduction	N/A	N/A	90	7,190	N/A	N/A

[a] Total average reported performance for four sites

[b] Total average evaluated performance for four sites

Table 1-2. Summary of Technologies and Dispatch Strategies

Technology	Summer				Winter	
	Daily	Utility-Triggered Event	Vendor-Forecasted ICAP	Facility Peak	Utility-Triggered Event*	Facility Peak
Thermal Storage 1	X					
Thermal Storage 2	X					
Targeted Batteries		X	X	X	X	X
Manual Curtailment		X	X		X	
BMS Controls 1			X	X		
BMS Controls 2			X	X		

*Winter utility-triggered event would be based on the locational marginal pricing (LMP) trigger described above.

The evaluation team has identified nine key findings:

1. **Event performance varied by technology solution:**
    a. ***Targeted Battery and Manual Curtailment.*** Both solutions performed reliably and in accordance with their scopes of work and goals. The evaluated impacts for the targeted battery and manual curtailment demonstrations matched the vendor-reported impacts.
    b. ***BMS Controls.*** The software BMS control solutions did not provide a verifiable reduction of customer monthly peaks or summer system peak loads. Both BMS control offerings appear to have opportunities for optimization that might produce impacts verifiable through a combination of engineering and load analysis in future seasons.
    c. ***Thermal Storage 1.*** Thermal Storage 1 was successful in offsetting the rooftop unit (RTU) cooling load during the dispatch window; however, a majority of the RTUs selected for control were oversized and underutilized, resulting in low demand reduction. While this does not reflect the lack of ability or potential for the technology, it does mean demand response (DR) for demonstration participants was lower than committed. This vendor did not revise predicted demand reductions based on actual summer performance.
    d. ***Thermal Storage 2.*** Thermal Storage 2 was reliable and successful in shedding load during the dispatch window. The lower-than-reported demand reductions are entirely due to differences in the calculation methodology between the vendor and the evaluators. The vendor used a calculation methodology that systematically overstated reductions.
2. **System peak hour reduction.** The total evaluated demand reduction at the system peak hour (July 30, 2019, 5-6 p.m.) was 8,685 kW. The manual curtailment demonstration represented 91% of system peak impacts and 38% of participating customers.
3. **Winter event performance.** The 2018-2019 winter season did not have any high locational marginal pricing (LMP)-triggered events. A test event was conducted for the manual curtailment and targeted battery solutions near the end of the season. Both solutions performed as expected during the test event.
4. **Net energy impacts.** Thermal Storage 2 resulted in energy savings of 126,420 kWh during the 2019 summer season. Targeted batteries resulted in a net energy increase of 2,520 kWh during the 2019 summer season at an average seasonal efficiency of 66.1%. Manual Curtailment and Thermal Storage 1 were not expected or evaluated to have energy savings. There may be energy savings from the BMS Controls solutions, but

these impacts were not a primary objective of this demonstration and were not quantified.

5. **Recruiting.** A mix of recruiting approaches were employed for these projects, ranging from almost entirely vendor-driven to almost entirely account executive (AE)-driven. AEs were able to provide valuable leads and help with customer introductions but were not consistently available to help with customer follow-up due to competing responsibilities, such as other programs and customer support during winter storms. Vendors who took control of customer education and relationship-building during the second year of the demonstration project and had more success in recruiting.
6. **Delivery.** Six of the seven vendors experienced delays in implementation. The exception was the vendor with several customers already participating in ISO-NE forward capacity market (FCM) offerings through a mature manual curtailment program. The combination of newer DR technologies such as energy storage and newer vendors in the New England market exacerbated new program administrative challenges and delayed roll-out compared to expectations. The slower ramp-up does not indicate flaws in the solutions but does indicate that trial periods are necessary to work out complexities prior to full-scale deployment of newer solutions.
7. **Customer satisfaction.** Overall, customers participating with manual curtailment and thermal storage solutions were satisfied with the projects with average scores of 4.0, 4.3, and 3.7 out of 5. The BMS Controls and Targeted Battery customers rated their project satisfaction at 3 out of 5, indicating that while they were not dissatisfied with the projects, there is room for improvement.
8. **Storage technology education.** The energy storage (thermal and battery) market is nascent in Massachusetts and requires significant customer education. For thermal storage projects in particular, the demonstration facility proved valuable to showcase to other customers.
9. **Customer screening process.** The initial customer screening process was too lenient for the thermal storage solutions and BMS controls solutions, leading to failed applications at the time of installation, lower impact for the thermal storage vendors, and longer-than-anticipated installation processes for the BMS controls vendors.

The evaluation team identified opportunities for improvement that were unique to individual vendors or their technologies and provided them in separate technology-specific reports. The recommendations presented below are cross-cutting and apply generally or at least to multiple vendors. Since the demonstration projects have largely concluded, the recommendations address issues that are either meaningful to Eversource's full-scale active demand response

(ADR) initiative that launched in 2019 or applicable to other Eversource programs. They are categorized below into program-design-oriented recommendations and evaluation-oriented recommendations.

Program-Design-Oriented Recommendations

- **Recommendation #1: Provide feedback to vendors on calculation shortcomings.** Several vendor impact calculations the team examined have opportunities for improvement moving forward. These included average daily dispatch reductions for Thermal Storage 2, billed monthly peak demand reductions for targeted batteries, and billed monthly peak demand reductions and energy savings for BMS Controls 1.
- **Recommendation #2: Collect sufficient data to ensure project feasibility early in the participation process.** Data collection during the early stages of project development should be more thorough to ensure project feasibility. For example, Thermal Storage 1 had multiple instances where engaged customers began to do a lot of groundwork only to find out the solution was either incompatible with their RTUs or was not feasible due to spatial or installation constraints. During the screening site visit, the vendor should verify that the preexisting RTUs have sufficient space for an additional cooling coil, confirm that the proposed location of the solution would be feasible for installation, and perform enough building cooling load or billing analysis to be confident that the affected space will call for near-capacity cooling output during dispatch hours. Similarly, Thermal Storage 2 had customers who were unable to participate because old refrigeration compressors were in poor condition. BMS Controls 2 also had a site that was delayed significantly when the vendor learned the site's BMS functionality did not have the necessary points of control.
- **Recommendation #3: Vet M&V plans.** Vendor M&V plans did not always contain sufficient detail on how vendors would quantify demonstration performance metrics. In particular, the two BMS solutions were not able to be fully evaluated due, in part, to a lack of detail on M&V requirements and methods. While the demonstration projects were not pay-for-performance (P4P) offerings, the full-scale program is a P4P program. For a pay-for-performance program, being able to quantify performance in a defensible manner would be particularly important.
- **Recommendation #4: Require clear, quantifiable goals and performance metrics, and standardize reporting of DR strategies and delivered performance.** Require vendors to provide site-specific DR strategies, performance goals, and delivered performance in a standardized manner.
- **Recommendation #5: Require local presence of vendor marketers or plan longer ramp-up periods.** The evaluation team found that out-of-state vendors without a local marketing presence generally had a more difficult time recruiting and longer ramp-up

periods than those with staff dedicated to demonstration recruitment in Massachusetts. While not a fix-all, having a local marketing representative responsible for sharing customer education and rapport-building efforts with utility AEs is expected to accelerate customer recruitment.

Evaluation-Oriented Recommendations

- Recommendation #6: **Involve M&V contractor during DR feasibility testing to allow for real-time verification of manual curtailment and BMS controls projects**. In order to prevent customer fatigue, and to allow for an easier evaluation of the implemented projects, the BMS controls and manual curtailment project vendors should include the evaluation team in the feasibility testing phase of the projects. This will allow evaluators to understand the equipment operation and load reduction through the test, rather than having to conduct an additional site visit for the same purpose.

2 Design of Demonstration Projects

Eversource contracted with six vendors and later added a seventh to deploy four peak demand reduction technologies with a variety of dispatch strategies over two summer seasons and one winter season starting in the summer of 2018. Eversource is also administering a pay-for-performance full-scale active demand reduction initiative that was evaluated and reported on separately.

Eversource's goals for the demonstration project are to understand the following: impacts on summer and/or winter peak consumption, customer acceptance of the various solutions, barriers and drivers to program implementation, and the ability of the demand demonstration projects to complement efficiency programs, among other topics.

The evaluation team tested the following dispatch strategies and technologies as part of this demand demonstration project. The team's goal for this project was to study the effectiveness of various technologies and dispatch strategies in reducing the utility peak demand.

2.1 Dispatch Strategies

Dispatch strategies use a set of criteria to determine when and how a DR resource is deployed to mitigate peak load. This section describes the different dispatch strategies the team studied as part of this demonstration project.

2.1.1 Daily Dispatch

Daily dispatch involves the dispatch of DR resources during scheduled windows daily throughout the summer season (June through September).

2.1.2 Utility-Triggered Event Dispatch

Event-based dispatch involves the dispatch of DR resources based on a utility-called peak load event. These events could be on any day and hour during the summer season (June through September). The utility event trigger aims to forecast the Installed Capacity Tag (ICAP) hour. The ICAP hour is the ISO-NE system peak hour for the entire year.

During the winter, events were called based on real-time LMPs at the 5-minute level spike above $500 per MWh within a load zone within Eversource's territory (NEMA, SEMA, WCMA) during business hours (8 a.m. – 6 p.m.) on non-holiday weekdays.

2.1.3 Vendor-Triggered ICAP Hour Forecasting Dispatch

This dispatch strategy involves customized algorithms seeking to forecast and dispatch to shed load during the predicted ICAP hour. These algorithms were developed by the vendors.

2.1.4 Facility Monthly Peak Demand Mitigation

This dispatch strategy uses customized algorithms that seek to mitigate facility monthly demand by setting a reference peak demand value and dispatching to prevent the facility from crossing the reference value. The facility monthly peak demand sets the demand charge for the month for the customer, therefore limiting the monthly peak demand reduces the monthly demand charges. These algorithms were developed by the vendors with input from the facility staff.

2.2 Technologies

The evaluation team studied the following four technologies as part of this demonstration project.

2.2.1 Thermal Storage

Two thermal storage solutions were deployed to test their effectiveness in mitigating utility peak demand during the summer months. One solution sought to limit peak demand by reducing summer air conditioning loads at commercial and industrial facilities, while the other solution sought to limit peak demand by reducing refrigeration loads at cold-storage facilities. Both solutions were deployed daily during scheduled dispatch windows in the summer. The dispatch windows were modified during the season to meet the anticipated ICAP hour. Neither solution participated in the winter season.

2.2.2 Batteries

A targeted battery solution was deployed to test the effectiveness in mitigating year-round utility peak demand. During the summer, this solution was deployed to mitigate peak load during Eversource-called events (typically 2-hour dispatch) and through a customized approach to mitigate the load during the ICAP hour (typically 3-hour dispatch during potential ICAP forecast hours). During the winter, both solutions were dispatched according to real-time LMPs at the 5-minute level spike above $500 per MWh within a load zone within Eversource's territory (NEMA, SEMA, WCMA) during business hours (8 a.m. – 6 p.m.) on non-holiday weekdays. The evaluation team also evaluated a daily dispatch battery demonstration solution and reported on it separately.

2.2.3 Manual Curtailment

Eversource selected one manual curtailment provider to test the strategy of targeted demand reduction for the annual utility peak. With manual curtailment, the provider and participant agree in advance on the amount of load reduction that the site can deliver. The provider does not install any equipment or controls and is not involved with how the participant reduces load. Most participants reduce HVAC or lighting loads or temporarily reduce production, but it is up to them to choose which equipment to shut off and how to activate the intervention. (Activation may be manual or programmed by the participant, and the nature of the response may vary from event to event.)

This solution utilizes active DR to reduce demand during peak periods. During the summer availability period, DR is dispatched with the intent of being active during the ISO peak load hour. During the winter availability period, DR is dispatched according to real-time LMPs at the 5-minute level spike above $500 per MWh within a load zone within Eversource's territory (NEMA, SEMA, WCMA) during business hours (8 a.m. – 6 p.m.) on non-holiday weekdays. The duration of each dispatch is between 1 and 4 hours, with up to 20 dispatch hours during the summer and up to 8 hours during the winter.

2.2.4 Building Management System Controls

The evaluation team assessed BMS controls for their ability to reduce a facility's load during system peak hour and the facility monthly billed peak demand. Utilizing this technology is similar to manual curtailment in that load reduction can come from HVAC, lighting, refrigeration, process equipment, or other non-critical systems like fountains or lobby TV screens. The BMS controls solution differs from the manual solution in the way customers are alerted to the need for DR, the types of events that trigger the alerts, and the pre-arrangement of actions taken.

To assess when conditions are ripe for energy reduction, a relay device was installed on the customer's meter that monitors consumption relative to their monthly peak. Depending on the customer's preference, when a trigger condition is met, the relay device either sends a signal to the customer's BMS (which has been programmed by the customer's BMS contractor to automatically take a predetermined action to reduce energy use) or alerts the customer through lights, horns, or some other notification to manually make the adjustment. The triggers used in this demonstration project are when a customer nears 95% of their monthly peak, or when a potential ISO-NE ICAP hour is forecasted. There is no utility-triggered DR component to the BMS controls solution. The BMS controls solution also expected to see some "passive demand reduction" through permanent load reduction and optimization of energy systems.

2.2.5 Summary of Technologies and Dispatch Strategies

Table 2-1 shows which dispatch strategies each technology implemented in the demand demonstration project.

Table 2-1. Summary of Technologies and Dispatch Strategies

	Summer				Winter	
Technology	Daily	Utility-Triggered Event	Vendor-Forecasted ICAP	Facility Peak	Utility-Triggered Event*	Facility Peak
Thermal Storage 1	X					
Thermal Storage 2	X					
Targeted Batteries		X	X	X	X	X
Manual Curtailment		X	X		X	
BMS Controls 1			X	X		
BMS Controls 2			X	X		

*Winter utility-triggered event would be based on the LMP trigger described above.

3 Evaluation Objectives

The objective of the impact evaluation is to verify that the various solutions succeeded in meeting their demand demonstration goals through performance verification, site visits, and baseline verification. The objective of the process evaluation is to understand customer acceptance and experience with the equipment or intervention, the readiness of systems for larger deployment, and PA and vendor success in delivery. The impact and process evaluations will help Eversource answer the question: "Should we offer this at scale?"

Table 3-1 lists all the identified crosscutting researchable questions.

Table 3-1. Crosscutting Evaluation Researchable Questions

Cross-Cutting	
Successful customers: What are the characteristics of successful participants for this technology? What delivery channels are most appropriate/effective for various customer types?	
Value streams: What benefits/value streams does the solution provide to customers? To the utility?	
Degree of automation: How automated is the solution, and what advantages and disadvantages does that entail?	
Barriers: Are there technological, economical, or regulatory barriers to full-scale deployment of the solution?	
Impact	**Process**
Magnitude of reductions: How much demand reduction is the solution able to provide? How does that compare to their SOWs? How does that compare to what was promised to customers?	**Customer recruitment:** How did the recruitment process compare to vendor/PA expectations? What were successes and barriers?
Efficiency: What are the net energy usage implications of the solution, if any?	**Motivations:** What were the customers' key motivations for participation? What benefits did they find most compelling?
Complementarity with other strategies: Is the solution mutually exclusive with other peak demand reduction strategies, or is it complementary?	**Satisfaction:** Are the participants satisfied with their experience? Are they satisfied with the solution? What could be improved?
M&V strategy: What is the most effective M&V strategy for this solution?	**Non-energy benefits:** What non-energy benefits, if any, does the solution provide to the customer or PA?
Cost-effectiveness: What is the most cost-effective solution? (Consultants to develop kW data, Eversource to analyze dollars.)	**Integration into business:** How well was the solution able to integrate into existing systems and business practices? How well does it "open the door" for additional demand or energy reductions?
Territory-wide potential: This will be a separate study out of the consultant scope.	**PA satisfaction:** How satisfied is the PA with the vendor? Were there any challenges or best practices that could be replicated in design, recruitment, data collection, and data transfer between the two parties?

4 METHODOLOGY

4.1 Process Evaluation Methodology

For the process evaluation, the team studied the requirements and procedures in place to achieve demand reductions; the team also investigated the ways that the program can most effectively reach its goals. The evaluation team used several primary data collection activities over the course of this evaluation:

- **Interviews with the Eversource program managers.** The evaluation team conducted interviews with the two program managers overseeing the vendors as well as two Eversource staff involved in designing and supervising the demonstration projects. These interviews were conducted at the beginning and end of each season of activity.
- **Interview with the vendor project managers.** The evaluation team interviewed each vendor's project manager for the Eversource demand demonstration project at the beginning of the 2018 summer season and at the end of each season of activity. The team used these interviews to clarify each vendor's approach, their experience with Eversource, and any successes or challenges.
- **Participant pre-summer surveys.** Whenever possible, the evaluation team conducted a site visit to verify the installation and operating schedules for the impact evaluation, at which time the team also conducted a pre-summer survey with the participant. If the survey could not be conducted on-site, the evaluation team followed up via email and phone.
- **Participant post-summer surveys.** The evaluation team emailed a customer experience survey to all customers participating in a demand demonstration project at the end of each season of activity to assess their satisfaction and experience. These surveys were tailored to the particular vendor and technology.
- **Marketing material review.** The evaluation team received and reviewed one-page marketing brochures for each vendor, as well as the overall demand demonstration fact sheet. Eversource also provided a slide deck that was used to educate their AEs on each vendor's technology and target customers.

Table 4-1 provides a summary of the interviews and surveys conducted in the first year of the evaluation.

Table 4-1. Summary of Year 1 Interviews and Surveys

Survey/Interview	Pre-Summer	Post-Summer	Total
Eversource project manager interviews	2	2	4
Eversource design/supervisory staff interviews	2	2	4
Vendor program manager interviews	0	6	6
Participant surveys	5	14	19
Total	**9**	**24**	**33**

4.2 Impact Evaluation Methodology

For the impact evaluation, the evaluation team utilized several different methods and strategies to calculate the performance of the various demand demonstration project technologies. Table 4-2, below, presents an overview of the methods used among demonstrations. In summary, the methods included verification site visits for all demonstrations, spot measurements for three solutions, data logging for one solution, and analysis of either interval data or equipment data for each affected site.

Table 4-2. Summary of Demonstration Evaluation Methods

Demonstration	Method			
	Site Visits		Primary Analysis Approach	
	Spot Measurements	Verification	Interval Data	Equipment Data
Thermal Storage 1	X*	X		X
Thermal Storage 2		X		X
Targeted Batteries	X	X		X
Manual Curtailment	X	X	X	
BMS Controls 1		X	X	
BMS Controls 2		X		X

*This solution involved data logging in addition to spot measurements.

For manual curtailment projects, the team used the utility interval data to quantify the delivered demand reduction during their respective dispatch windows. This analysis included a review of final settlement impacts and curtailment estimates based on several alternative baselines, including a regression baseline. In addition to interval data, the evaluation team obtained a combination of trend data and spot measurements for a sample of equipment during the site visits to better understand the demand reduction strategies employed by the vendors.

For BMS Controls 1, the evaluation team used an ex-post regression approach to capture active demand reduction caused by the DR solution as well as a “meter before meter after” (MBMA) analysis. During the site visits, the evaluation team collected BMS trend data and verified the accuracy and feasibility of the audit reports and sequence of operations provided by the vendor.

For BMS Controls 2, the team did not conduct an impact evaluation because no meaningful demand reductions were claimed or expected.

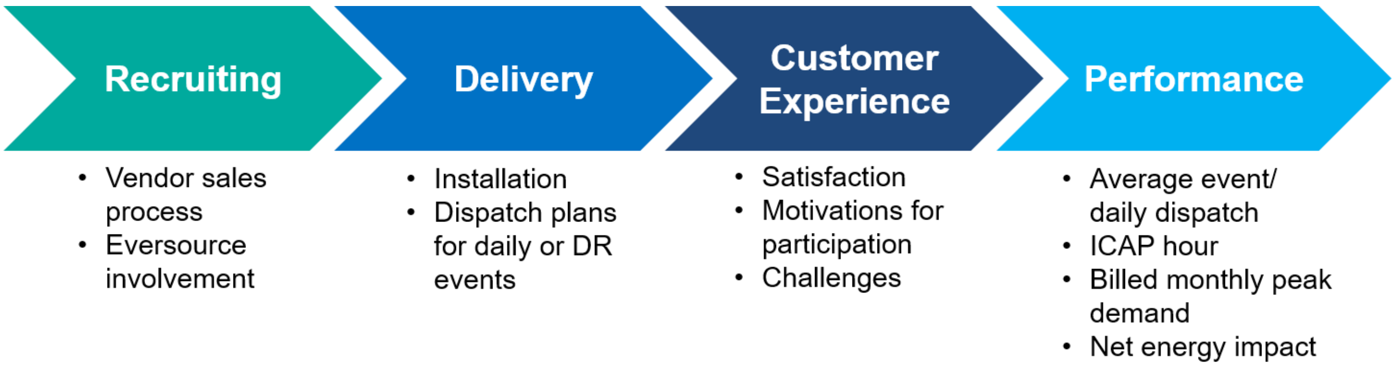
For thermal storage projects, the team used the power draw of the affected equipment to quantify the delivered demand reduction during the dispatch windows. During the site visits, the evaluation team verified the space temperatures of affected spaces, confirmed the nameplate and controls of existing equipment, and obtained trend data from the BMS where available. The team analyzed utility interval data to estimate the customer monthly billed peak demand reductions.

For the targeted dispatch (battery) storage project, the evaluation team used the battery charge and discharge data to quantify the delivered demand reduction during their respective dispatch windows. The analysis also used facility interval data and included site visits. During the site visits, the evaluation team verified that the battery meters were revenue grade meters. If they were not, the evaluation team took spot measurements of the battery output and compared the values to the battery meter.

5 EVALUATION FINDINGS

This section describes the evaluation findings, grouped into four components of the project's implementation, as shown in Figure 5-1.

Figure 5-1. Evaluation Findings Categorization



The following sections are arranged by the four technologies, each speaking to the evaluation findings visualized above and insights on lessons learned, where applicable.

5.1 Thermal Storage Findings

5.1.1 Thermal Storage Recruitment

The goal of Thermal Storage 1's scope of work was to enroll 19 customers by the end of 2019, for a total reduction of 501.6 kW. The goal of Thermal Storage 2's scope of work was to enroll 11 customers by the end of 2019, for a total reduction of 1,500 kW. Due to a host of issues, both thermal storage vendors struggled to recruit participants during the inaugural year of the demonstration project in 2018. Elongated contracting processes with Eversource caused recruiting delays for both vendors. Thermal Storage 1 was unable to begin recruitment efforts in earnest until the middle of the 2018 summer peak period, and Thermal Storage 2's recruitment kicked off only right before the 2018 summer began. In 2019, enrollment increased to eight customers and 241 kW for Thermal Storage 1, and eight customers and 1,270 kW for Thermal Storage 2.

The evaluation team found that both vendors encountered the following issues:

- **Eversource recruitment support and constraint.** Though Eversource provided invaluable leads to both vendors, many of which were converted to participants in the demonstration project, the lack of follow-through from some of the AEs was a detriment to the recruitment process. Both vendors stated that, while the main Eversource Project Manager (PM) was consistently engaged and responsive, the inconsistent involvement of

Eversource AEs resulted in significant delays in recruitment and led both vendors to take control of the recruitment process.

- **Customer education.** A large part of the recruitment effort was simply providing education on the value of demand reduction and thermal storage to customers, contractors, and even Eversource AEs scanning for potential leads. One of the best sales tools was having potential customers tour completed projects.
- **Equipment considerations beyond cost.** Although the equipment was 100% free to the customer through the demand demonstration project, there were other considerations that gave customers pause. These considerations included integrity of the roof or freezer racks to support additional load, staff availability to help with installation and integration, required piping modifications, and integration with existing controls.
- **Delays in paperwork and final sign-off.** Once larger customers verbally agreed to participate in the demonstration projects, internal corporate procedures created delays in obtaining the signed agreements and applications to commence work. One vendor remarked that they should have insisted upon signing at least an initial agreement with the customers sooner in the sales process. Moving forward, this was something the vendor planned to implement.

Vendor-specific obstacles included the following:

- **Thermal Storage 1: Incompatibility with targeted RTUs.** Thermal Storage 1's solution included the installation of a secondary cooling coil within the targeted RTUs. This proved to be a major challenge. Multiple large customers with several RTUs were unable to participate because their RTUs were not large enough to accommodate the installation of an additional cooling coil. This resulted in frustration and a bad customer experience, as a lot of time had been sunk into this effort before the incompatibility issues were identified.
- **Thermal Storage 2: Narrow customer segment.** Thermal Storage 2 had the narrowest targeted facility type of the demand demonstration projects, as their technology is effective only for cold storage facilities with large freezers (not refrigerators). They were looking for customers with a substantial amount of freezer area, the ability to shut off the refrigeration system, a location where the freezer is largely closed off to minimize airflow, and a storage space rather than a process line. This greatly minimized the pool of customers they could recruit.

5.1.2 Thermal Storage Delivery

Once the systems were operational, the vendors scheduled their systems to discharge daily, typically targeting between 3:00 p.m. and 7:00 p.m. The intent was to "set and forget" the dispatch schedules to allow for minimal interruption from facility staff. During the installation of the solutions, however, the following barriers to implementation were identified:

Thermal Storage 1

- **Delivery and installation of equipment.** Due to the size of the equipment, all but one facility had difficulty getting the equipment to the proposed locations at the sites. This resulted in delays and, in some cases, cancellation of installations.
- **Controls integration challenges.** The targeted facilities were mostly small to midsize facilities where maintenance personnel were not intimately familiar with the existing HVAC controls. In some cases, the controls were maintained by third-party providers. This resulted in challenges in integrating the thermal storage solutions and controls with existing HVAC controls.
- **Lack of load.** A significant challenge faced by Thermal Storage 1 across all eight facilities was that the affected RTUs were oversized and underutilized, thereby reducing the potential for demand reductions during the dispatch hours. Even though the systems were installed, operational, and available throughout the season, they often had little load to offset. This challenge was confirmed by the impact evaluation. This drives home the importance of including metering of targeted RTUs in the customer screening process to ensure that they are sufficiently loaded during peak hours.

Thermal Storage 2

- **Controls integration and automation challenges.** Some facilities did not have adequate existing refrigeration system controls in place to allow for the automation of the thermal storage solution. In these cases, the vendor had to work with the facility refrigeration vendors to install more advanced controls. Other facilities with adequate controls stated they preferred to integrate the solutions themselves but were unable to dedicate staff to the integration in time for the start of the 2019 summer season. These sites had to dispatch manually until the integration of controls could be completed.
- **Additional paperwork.** Due to the type of refrigerant used in one participating facility, the installation of the new thermal storage solution meant that they had to report the change in operations to the EPA, thereby leading to delays in installation and controls integration.
- **Poorly maintained equipment.** Failed compressors at one participating facility prevented them from operating at the space temperatures for which the phase change materials (PCMs) were designed. The facility was unwilling to replace their failed compressors, meaning that the PCMs were ineffective. This site could not be dispatched for a majority of the season. The Eversource PM mentioned that, moving forward, it could be useful for

vendors to vet customers and their commitment to the upkeep of not only the installed technologies but also their existing systems, especially for programs that pay all upfront costs. This would protect the interests of all stakeholders involved (i.e., Eversource, the vendor, and the customer).

- **Racking arrangement and condition.** Some participating sites required racking modifications in order to be an effective participant in this project. This added unexpected cost, time, and complexity to the installation.

5.1.3 Thermal Storage Customer Experience

Both vendors had eight sites installed and operational during the 2019 summer. The evaluators reached out to survey all participants; the team received responses from three Thermal Storage 1 customers and three Thermal Storage 2 customers. Participants were asked to rate their satisfaction with various project components on a scale of 1 to 5, with 1 being "very dissatisfied" and 5 being "very satisfied." The customer satisfaction survey results are summarized in Tables 5-1 and 5-2.

Table 5-1. Customer Satisfaction Ratings (Out of 5) – Thermal Storage 1

Program Component	Average Rating (N=8, n=3)
Vendor information	4.7
Vendor technology/solution	4.3
Interactions with vendor	5.0
Demand/energy reduction	4.7
Cost savings/financial benefits	4.0
Eversource involvement	4.0
Overall project	4.3

N – Total number of participants

n – Number of participants who responded to the customer satisfaction survey

Thermal Storage 1 customers were satisfied with the overall project and solution, giving both an average rating of 4.3 out of 5. They reported being particularly satisfied with their interactions with the vendor, for which all customers gave a 5 out of 5 rating. The customers indicated that, while they have not yet seen the impact of the solution on their energy bills, they are expecting good results based on the preliminary performance snapshots. The customers indicated that they did not experience any changes to their comfort levels after the installation of their solutions. This is consistent with the feedback provided to the impact evaluation team during site visits.

Table 5-2. Customer Satisfaction Ratings (Out of 5) – Thermal Storage 2

Program Component	Average Rating (N=8, n=3)
Vendor information	4.7
Vendor technology/solution	4.0
Interactions with vendor	4.3
Demand/energy reduction	3.3
Cost savings/financial benefits	3.3
Eversource involvement	4.0
Overall project	3.7

N – Total number of participants

n – Number of participants who responded to the customer satisfaction survey

Two out of three customers were very satisfied with this project overall, while one customer was dissatisfied with multiple aspects. The two satisfied customers gave a rating of 5 out of 5 for their interactions with the vendor and the technology. One of the two customers (the vendor's first demand demonstration project installed over the 2018 summer season) stated that they were more satisfied in the 2019 summer than they were with the previous summer. However, they also stated that they would like a better understanding of the achieved demand and cost savings. The other customer stated that the added benefit of the solution increasing facility reliability in case of lost power was very important to them.

The remaining customer rated most project components between a 2 and 3 out of 5. The customer stated that the vendor did not have a sufficient understanding of their refrigeration systems and felt their implementation plan lacked detail and safety protocols crucial for the maintenance of their refrigeration technology. They also rated the demand reductions and financial benefits as a 2 out of 5, stating that they were below expectations. Of note, this customer outperformed the vendor's estimated reduction by 70% based on the vendor's calculation methodology; however, they underperformed by 27% based on the evaluator's calculation methodology.

5.1.4 Thermal Storage Performance

Thermal Storage 1

For the 2019 program year, the vendor committed an average load reduction of 241.0 kW across eight sites during the three-hour daily dispatch window. The vendor's reported value was the same as its committed value and was not revised based on performance at the end of the season. As shown in Table 5-3, the vendor provided an average demand reduction of 61.9 kW during this window. The ISO-NE system peak (ICAP) hour occurred on July 30, 2019, from 5 p.m. to 6 p.m. During the ICAP hour, this vendor provided 86.1 kW of demand reduction. No energy use reduction (kWh) and customer monthly peak demand reductions were claimed, expected, or evaluated for this solution.

Table 5-3. Thermal Storage 1 Performance Summary

Load Categorization	Daily Dispatch Reduction (kW)	ISO-NE ICAP Hour Reduction (kW)	Customer Monthly Peak Reduction (kW)	Net Energy Impact (kWh)
Committed	241.0	N.R.	N.R.	N.R.
Reported	241.0	N.R.	N.R.	0
Evaluated	61.9	86.1	56.4	0

N.R. = Not reported

It is important to note that the technology works as intended and reliably sheds cooling load during the summer peak hours. The difference between reported and evaluated savings is not due to technology functionality. The primary causes for the underperformance are oversizing and underutilization of RTUs. The second stage of cooling almost never came on for a majority of the units. These two issues were systemic across all eight sites.

The evaluators did not notice a distinct relationship between facility type and the thermal storage solution performance. However, it was observed that low load RTUs must be avoided in order to achieve expected demand reductions. Looking carefully at unit size relative to space size and type served, and metering of the RTUs in the summer or shoulder season before installation if possible, would help achieve predicted performance.

Thermal Storage 2

For the 2019 summer, the vendor committed an average load reduction of 1,270.0 kW across eight sites during the three-hour daily dispatch window. As shown in Table 5-4, the vendor provided an average demand reduction of 515.6 kW during this window. The ISO-NE system peak (ICAP) hour occurred on July 30, 2019, from 5 p.m. to 6 p.m. During the ICAP hour, this vendor provided 576.8 kW of demand reduction. The average customer monthly peak reduction was found to be 252.6 kW.

Table 5-4. Thermal Storage 2 Performance Summary

Load Categorization	Daily Dispatch Reduction (kW)	ISO-NE ICAP Hour Reduction (kW)	Customer Monthly Peak Reduction (kW)	Net Energy Impact (kWh) [c]
Committed	1,270.0	N.R.	N.R.	N.R.
Reported (peak during baseline period)	1,110.0 / 1,246.0 [a]	N.R.	N.R.	138,148
Evaluated (average during baseline period)	515.6 [b]	576.8	252.6	126,420

N.R. = Not reported

[a] The monthly Excel-based performance reports provided by the vendor showed an average reduction of 1,110 kW. ERS was able to replicate this value. The vendor later sent ERS an end-of-season PDF report that showed reductions of 1,246 kW. It is unclear why the reductions changed between the performance reports and the end of season report. Since ERS successfully replicated the performance reports, the team used 1,110 kW as the basis of comparison in the evaluation discrepancy table.

[b] One site shed load from 11 a.m. to 3 p.m. instead of the 3 p.m. to 7 p.m. window. The site's load and load reduction were essentially independent of time of day. Evaluators believe that DR would be similar if their event period also was 3 p.m. to 7 p.m., and thus included the reductions in the aggregate results.

[c] Positive values indicate that energy savings were achieved.

Although Thermal Storage 2 performed as per their scope of work for a majority of sites, there were significant variations between the evaluator-reported reductions and the vendor-reported reductions. These discrepancies are entirely due to differences in calculation methodology and not due to system performance. The differences in analysis methodologies include:

- **Baseline definition.** The vendor defined the load reduction as the maximum kW value within the baseline period minus the average kW values during the post-installation dispatch windows. The evaluators defined the load reduction differently, taking the average kW during the baseline period minus the average kW during the post-installation dispatch windows.
- **Baseline data collection period.** The vendor used the pre-installation spring season data to calculate the baseline power draw while the evaluators used the non-event hours during the summer season to calculate the baseline power draw.
- **Pre-existing demand management system.** One site already had advanced refrigeration controls prior to the installation of the thermal storage solution. The pre-existing controls already reduced system load during the dispatch hours. Evaluators focused on the marginal additional demand reduction provided by the installation of the solution while the vendor attributed the total reduction during the dispatch hours to their solution.

Table 5-5 summarizes the reasons for the discrepancy and their relative impact.

Table 5-5. Thermal Storage 2 2019 Discrepancy Summary

Reason	Magnitude of Effect
Calculation method: baseline definition	-46%
Calculation method: baseline data collection period	+16%
Calculation method: pre-existing demand management system (one site only)	-24%
System performance	*less than 0.5%*
Total discrepancy between reported and evaluated DR	**-54%**

The evaluation team observed that cold-storage facilities without pre-existing load management systems are good candidates for the PCM and refrigeration controls. Facilities with advanced refrigeration controls should either be avoided or the marginal DR expectations for them must be vastly lowered.

Net Energy Impacts

The net energy impact of Thermal Storage 1's solution was not reported or evaluated. Thermal Storage 2's solution was evaluated to have significant energy savings during the 2019 summer season. The details regarding net energy impact for each vendor are as follows:

Thermal Storage 1

There are theoretical energy impacts from night ice-making thermal storage.[2] The vendor did not claim, and ERS did not attempt to measure, any net energy changes due to these considerations.

Thermal Storage 2

The evaluators calculated the net energy impact of this solution by calculating the percent change in system daily energy use for 2019 summer weekends (no load shedding) and weekdays (with load shedding). To normalize for weekday-weekend differences not due to load shedding, the same comparison was made for the pre-installation period and used to adjust the percentage. The 4.6% energy savings factor that was obtained from the two sites with sufficient data (weekend and weekday, pre- and post-installation) was applied to the six sites without sufficient data to calculate the energy savings. The net energy savings based on this approach was found to be material (126,420 kWh), indicating that the refrigeration system was more efficient with the PCM and controls.

[2] In theory, there are efficiency gains due to higher compressor discharge pressure (units running more at night when it is cooler outside), and less cycling (the system runs steadily at night to make ice instead of cycling to provide the right amount of cool air). These gains are at least partially offset due to higher compressor suction pressure (it takes colder, more pressurized refrigerant to make ice than to make cool air) and by conduction losses associated with ice storage.

Customer Billed Monthly Peak Demand

The customer monthly peak demand is the charge that each customer pays on their transmission and distribution electric bills based on their maximum usage during a rolling 15-minute window during the utility-defined on-peak hours.

Thermal Storage 1

Thermal Storage 1 did not claim, is not expected to result in, and was not evaluated for monthly peak demand reductions.

Thermal Storage 2

There were three types of sites the evaluators encountered during this analysis:

- One site that was excluded because they had advanced controls reducing monthly peak demand prior to this solution
- Sites whose peak demand was not set during the dispatch window and so had no reductions
- Sites who would have set their monthly peak demand during the dispatch window – the evaluation team quantified the total peak demand reduction for these sites

The total monthly peak demand reductions across all eight sites equaled 252.6 kW. Over 70% of the total reduction achieved was from one site that dispatched from 11 a.m. to 3 p.m. instead of the typical 3 p.m. to 7 p.m. window.

5.2 Targeted Batteries Findings

5.2.1 Targeted Batteries Recruitment

The vendor's original scope of work listed a goal of enrolling 10 customers by summer 2019 for a total of 2,500 kW. However, during their initial recruitment cycle, the vendor faced several challenges that slowed their recruitment efforts. The vendor requested and received an extension in their contract through summer 2020 due to recruitment challenges.

The vendor is a California-based company and, until late 2018, did not have a local representative in Massachusetts. Early in the demonstration, the vendor relied heavily on Eversource staff to attend in-person recruitment meetings and site walk-throughs with East Coast customers. The Eversource PM reported that finally having a local vendor sales representative on the ground was critical for customer education and relationship development, which had not been as effective when conducted over conference call during the first year of the project.

One of the biggest challenges that the vendor reported from the recruiting side was related to assessing customer's exposure to ICAP charges. The structure of some third-party supplier bills makes it difficult to determine if a customer is exposed to ICAP charges. As this is a key financial benefit, the project economics may not work out if the supplier does not pass the ICAP charges through to the customer, so it is critical for the vendor to quickly determine whether the customer will likely save enough to justify the project. The vendor PM reported that a major takeaway from their participation in the demonstration was the need to proactively obtain customer bills and reach out to third-party suppliers for clarification on certain bill components. As the demand project progressed, this allowed them to confirm a customer's ICAP charge exposure before getting too far along in the sales process.

The vendor was successful in installing a system with its first customer in summer 2018, with a second installed in fall 2018. In December of 2019, the Eversource PM reported that there were four sites projected to come online in February 2020 and an additional three in May. Once these projects are operational, the vendor will have met the capacity goal established in their statement of work. The Eversource PM was very pleased with this outcome and voiced satisfaction at the variety of customer types that had contracted for this vendor's projects.

5.2.2 Targeted Batteries Delivery

Both of the projects the vendor developed during the first year of the demonstration were under 500 kW and, as such, did not trigger a more rigorous or lengthier interconnection review. However, in 2019, the vendor submitted interconnection applications for three demonstration projects with systems sized just over the 500 kW threshold. The vendor PM knew that Eversource was investing resources in accelerating their interconnection process for larger distributed energy resources and was confident that they would have the three systems installed by the beginning of the summer 2020 season.

5.2.3 Targeted Batteries Customer Experience

Following the winter 2018-2019 season, ERS surveyed both customers with operational systems as well as two new customers farthest along in the recruitment process (and for whom the vendor had provided contact information). The evaluation team received responses from both participants with operational systems, but only one participant's responses were clear enough to use.[3] The participant indicated that the project lowered demand charges but the financial benefits had been lower than expected. The site contact believed they would see greater

[3] One participant was unable to provide definitive answers for most questions and reported a general lack of familiarity with the project but still provided rankings for various project components. The evaluation team followed up with this customer numerous times to understand the motivation behind their rankings. Ultimately, the site contact did not provide further context for their survey responses.

financial benefits over time. The customer ranked Eversource's involvement at a 4 out of 5 and gave the vendor's technology, vendor interactions, demand reductions, and the overall project a score of 3 out of 5.

Table 5-6. Customer Satisfaction Ratings (Out of 5) – Targeted Batteries

Program Component	Score (N=2, n=1)
Vendor's technology/solution	3
Interactions with vendor	3
Demand/energy reduction	3
Cost savings/financial benefits	2
Eversource's involvement	4
Overall project	3

N – Total number of participants

n – Number of participants who responded to the customer satisfaction survey

Prior to the summer 2019 season, the vendor had two demonstration projects installed and operational. As mentioned above, in December of 2019, the Eversource PM reported that there were four sites projected to come online in February 2020 and an additional three in May. Following the summer 2019 season, ERS sent online surveys to both customers with operational systems and three customers in the deployment phase (and for whom the vendor had provided contact information).[4]

Both installed customers and two committed customers in development did not respond to our repeated contact attempts. One customer, a large grocer in the process of installing a system, provided a response. The customer reported overall satisfaction with the project, giving a rating of a 4 out of 5 for the application/enrollment process and vendor-conducted site walk-throughs and curtailment plan development. The customer gave a rating of 5 out of 5 for the information they were provided explaining how the demonstration project works, their interactions with their vendor, the incentive, and the overall project. Because the customer was still in the installation process, they were unable to comment on the performance of the system or any demand or cost reductions from the project.

5.2.4 Targeted Batteries Performance

There were two participants in the summer 2019 and winter 2018-2019 targeted battery demonstration. Table 5-7, below, summarizes the impacts from the summer season.

[4] The vendor did not provide contact information for two prospective customers who hadn't yet signed contracts.

Table 5-7. Targeted Batteries Summer 2019 Impact Summary

Stage	Third-Party Event Hourly Reduction Average (kW)	Utility Event Hourly Reduction Average (kW)	ISO-NE ICAP Hour Reduction (kW)	Customer Monthly Peak Reduction Average (kW)	Seasonal Efficiency
Committed	116.7	116.7	N/A	N/A	N/A
Reported	107.6	104.7	108.1	56.2	N/A
Evaluated	107.6	104.7	108.1	29.9	66.1%
Hours	**12**	**3**	**1**	**N/A**	**N/A**

[1] The net energy impact was calculated based on a total of 7,443 kWh charge and 4,923 kWh discharge.

Figure 5-2 shows the demonstration-level battery charge (positive values) and discharge (negative values) from 2 p.m. until midnight for the five 3-hour summer 2019 demand response events called. The event start time is shown for each day (3 p.m. on 7/17 and 4 p.m. all other days). Each event period is shaded dark gray, and the ISO-NE ICAP hour is shaded black. This battery solution provided stable performance of more than 100 kW of demand reduction with minimal variation across days, with the exception of the final 15-minute interval of the August 19 event. The batteries began to recharge 3 hours after the completion of each of these events.

Figure 5-2. 2019 Summer Weekday Events – Aggregate

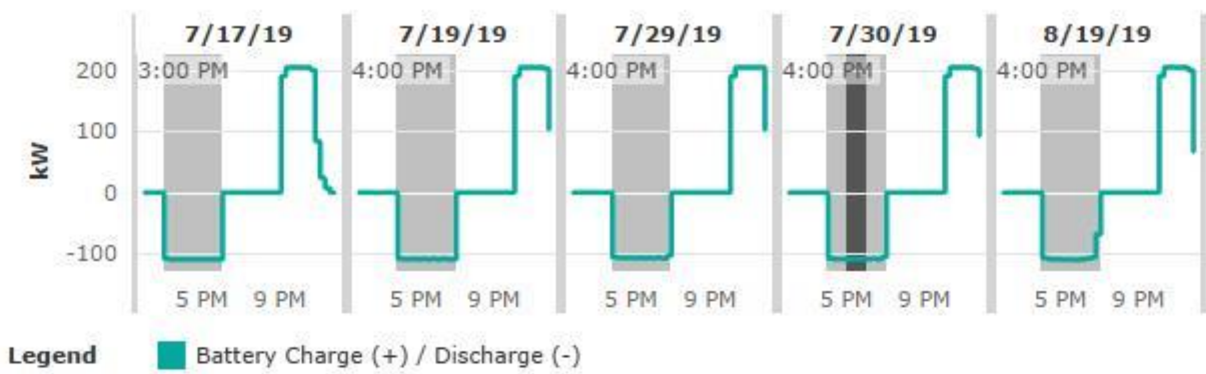


Table 5-8 presents the impacts from the 2018-2019 LMP winter season test event. The winter real-time ISO-NE LMP did not exceed the curtailment trigger (exceed $500 per MWh), so a test event was called and evaluated.

Table 5-8. Targeted Batteries Winter 2018-2019 Impact Summary

	LMP Test Dispatched Demand Reduction (kW)	Customer Monthly Peak Demand Reduction (kW)[3]	Battery Efficiency
Enrolled	N/A	N/A	N/A
Reported	89.7[1]	114.5	N/A
Evaluated	59.7 (89.6)[2]	66.6	61.4%

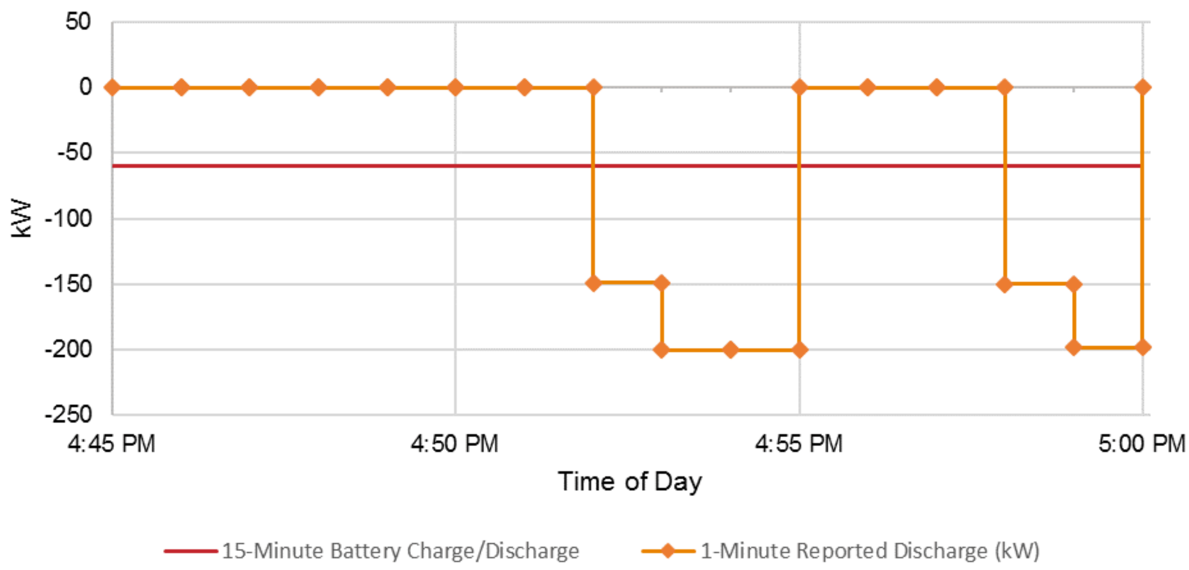
[1] The reported demand reduction for the LMP Test is the average of the reported discharges for each minute of the 10-minute event.

[2] 15-minute battery data was received from the vendor. For the LMP Test, the evaluated demand reduction of 59.7 kW (primary) is a 15-minute interval average, which includes time that occurred prior to the 10-minute event in which the batteries were not expected to discharge. The 10-minute event period demand reduction is 89.6 kW (parenthetical).

[3] Total average peak reduction is calculated November through March, as November is the first complete month in which both vendor batteries were operational.

Figure 5-3 shows the Friday, March 22, 2019 winter LMP Test result. The test was from 4:50 p.m. until 5:00 p.m.

Figure 5-3. LMP Test Dispatch – Friday, March 22, 2019



The evaluated average 15-minute battery discharge demand reduction for the winter LMP Test event was 59.7 kW. The 1-minute data in the graph illustrates a 2- to 3-minute delay between when the bid clears the market after the start of 5-minute intervals and the battery discharge begins; note the notifications from ISO-NE at 4:52 and 4:58. After the bid cleared at 4:50 p.m., the battery began to discharge shortly after 4:52 p.m. for the remainder of the 5-minute interval. Similarly, after the bid cleared at 4:55 p.m., the battery began to discharge shortly after 4:58 p.m. Ultimately, the battery discharged for some portion of 5 of 10 minutes for which the bid cleared.

The targeted batteries' total discharge, as captured in 1-minute intervals, ranged from 149 kW to 200 kW. The average demonstration-level discharge was 179.4 kW for the five 1-minute intervals in which the batteries discharged. The evaluated demand reduction during the 10-minute event period is 89.6 kW.

Net Energy Impacts

The vendor's batteries are capable of substantial and reliable peak demand reduction; however, the technology increases energy consumption. Battery charging consumption will always be greater than battery discharge due to operational energy losses (e.g., heat), battery self-discharge (e.g., idling losses), and the battery energy storage system operational load (e.g., maintaining temperature, creating and maintaining vacuum, etc.). The total charging consumption of the vendor batteries was 7,443 kWh, while discharge was 4,923 kWh over the 2019 summer season. This was a net increase of 2,520 kWh, which represents 66.1% seasonal efficiency for the battery solution. The vendor expected a battery cycle efficiency of at least 70%.[5]

Customer Billed Monthly Peak Demand

Reduced customer monthly peak load is a potential benefit to participating customers. Customers realize monthly bill savings to the extent that the battery can reduce their peak load during each billing period. Though not an explicit objective of the demonstration project, the vendor uses a type of shared savings agreement to pay for implementation costs. Customers bear no upfront costs for the battery or software. Instead, the customer pays a portion of estimated bill savings to the vendor as a service fee to offset the project costs.

For this evaluation, all sites are assumed to be on a large, general time-of-use rate and in the summer are charged according to the peak demand reached during the on-peak hours of 9 a.m. to 6 p.m. Results are examined on a calendar month basis, as billing month periods are unknown. This may affect the estimates of customer monthly peak load reduction, given that calendar month and billing month are not necessarily the same.

The vendor reduced customer peak load by an average of 29.9 kW at the demonstration level from May through August. The vendor reported an average demonstration-level reduction of 56.2 kW from June through August. Evaluated load reduction during the same time period is about one-third less than reported values. The vendor's calculation method reflects the battery discharge at the time that a customer's monthly peak would have occurred, in the absence of the battery, as opposed to the effective customer monthly peak reduction. Effective customer

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[5] The vendor scope of work states that, "while round-trip battery cycle efficiency is between 81% and 88%, batteries may exhibit lower efficiency during commercial operation due to the need to 'top off' the battery and maintain high state of charge even when the systems are not discharging."

monthly peak reduction is the difference between the site load peak that would have occurred, in the absence of the battery, and the site load peak that actually occurred, in a given billing period. Customer monthly peak reduction, as defined by the vendor, does not include information on the customer peak load (with battery) and will always be greater than or equal to the effective customer monthly peak reduction. The vendor's measure will overestimate the effective reduction to the extent that the maximum site load (with battery) is greater than site load at the time that the maximum site load (no battery) occurred. The vendor's approach is not a meaningful measure of peak load reduction for the customer.

5.3 Manual Curtailment Findings

5.3.1 Manual Curtailment Recruitment

Of the demonstration project vendors, the manual curtailment vendor had the smoothest and most successful recruitment process. This was largely because the vendor had an existing customer base from ISO-NE Forward Capacity Market (FCM) that it successfully leveraged; many of its participants in the demonstration project were already customers. The vendor had a total of 59 accounts representing 18 customers participating in the demonstration in the summer of 2018. Two additional customers participated during the winter 2018-2019 season, and five new customers were recruited prior to the beginning of the summer 2019 season. This put the vendor at 25 recruited customers, one above their goal of 24 participants by 2019. However, the vendor transitioned nine demonstration customers out of the demonstration and into Eversource's active demand reduction initiative before the summer 2019 event period, leaving 16 participating in the demonstration's final summer season.

5.3.2 Manual Curtailment Delivery

Over the summer 2018 season, DR events were triggered by a system peak forecast from either Eversource or the vendor. Over summer 2019, the vendor called DR events based solely on their own forecasting, independent of the utility. The vendor PM remarked that this made calling events easier and eliminated potential confusion around which signals to respond to, as there have been times where their forecasts have differed from those of the utility. The vendor called one weekday event on Tuesday, July 30, from 4 p.m. – 7 p.m., catching the ICAP hour (5–6 p.m.). The Eversource PA overseeing the vendor was satisfied with the demand reduction that resulted from the summer 2019 dispatches.

5.3.3 Manual Curtailment Customer Experience

Participants were asked to rate their satisfaction with various project components on a scale of 1 to 5, with 1 being "very dissatisfied" and 5 being "very satisfied." Overall, the vendor's customers were satisfied with their experience, with winter 2018-2019 and summer 2019 season respondents giving the program a rating of 4.3 and 4.0 out of 5, respectively. Throughout the demonstration, demand/energy reductions and cost savings/financial benefits scored slightly lower on average compared to other program components. Following the summer 2019 season, six respondents rated financial benefits with a 4 or 5 out of 5, two gave a rating of 3, and one gave a rating of 1.

Table 5-9. Customer Satisfaction Ratings (Out of 5) – Manual Curtailment

Participating Customer Survey	Average Rating	
Program Component	Post-Winter (N=20, n=13)	Post-Summer '19 (N=16, n=9)
Vendor's technology/solution	4.3	3.8
Interactions with vendor	4.5	4.0
Demand/energy reduction	3.7	3.6
Cost savings/financial benefits	3.5	3.7
Eversource's involvement	4.6	4.3
Overall project	4.3	4.0

N – Total number of participants

n – Number of participants who responded to the customer satisfaction survey

Manual curtailment can be less reliable in delivering demand reduction than equipment-based technologies for a host of reasons – for example, a dispatch call occurs during a time the customer cannot curtail; the facility receives complaints about room temperatures and decides to opt out; the person responsible for making the curtailment actions is on vacation or has left for the day; etc. For this reason, the vendor is careful to enroll considerably more capacity than they commit. As shown in the impact section of the report, the manual curtailment vendor exceeded their reduction targets and delivered more kW reductions than all other demonstration vendors.

The evaluation team explored if and how the potential limitations of manual curtailment impacted customer satisfaction. As expected, a few participants (5 of 20 winter participants, 6 of 16 summer 2019 participants) experienced some of the challenges listed above. That said, these participants gave average ratings of 4.4 out of 5 for the vendor's technology and 4.2 out of 5 for the overall program over the winter 2018-2019 and summer 2019 seasons. This suggests a general satisfaction amongst participants, despite some of the limitations of a manual curtailment approach. All but one participant said they would continue to use their DR solution.

5.3.4 Manual Curtailment Performance

The primary goal of the manual curtailment demand demonstration project is to reduce load during the ISO-NE annual system peak, or ICAP hour. In the summer of 2019, one mandatory participation weekday event was called on Tuesday, July 30, from 4 p.m. – 7 p.m. It succeeded in encompassing the ICAP hour (5–6 p.m.). The vendor also called two voluntary weekend events. Table 5-10, below, shows contracted, reported, and evaluated demand reduction results. The first column are those accounts with impact that evaluators were able to validate, while the second shows the reported kW for accounts without data. The final column shows the impacts during the ICAP hour.

Table 5-10. Manual Curtailment Summer 2019 Impact Summary Table

Demand Reduction	Average Load Reduction (kW)			ISO-NE ICAP Hour
	Common Accounts	Reported Only	Total	
Contracted	N/A	N/A	7,000	7,000
Reported - Settlement Baseline	7,204	682	7,886	8,409
Evaluated - Unadjusted	1,769	-	1,769	2,493
Evaluated - Settlement Baseline	7,190	-	7,190	7,914
Evaluated - Regression Baseline	420	-	420	1,208
Accounts	**51**	**5**	**56**	**56**

N/A – Not available

The regression baseline result is low for two primary reasons. First, the demonstration project had a substantial number of accounts with highly variable load. Second, three-quarters of the load for the accounts that were not highly-variable are non-weather-correlated, thereby undermining the regression baseline’s effectiveness in estimating the baseline load.

Figure 5-4, below, shows the actual load on the summer season event day (July 30), the unadjusted baseline shape, the adjusted settlement baseline, and the regression baseline. The adjustment period (2–3 p.m.) and event period (4–7 p.m.) are shown in light gray; the ISO-NE ICAP hour is shown in dark gray. The adjusted baseline tracks closely with actual load the morning of the event. The unadjusted and regression baselines significantly underestimate load and are of similar magnitudes. The actual load increases more rapidly on the morning of the event than baselines predict. This is expected for event days called on extreme days, such as the ICAP event day, where HVAC load is higher for customers with weather-correlated load.

Figure 5-4. Summer 2019 July 30 Event

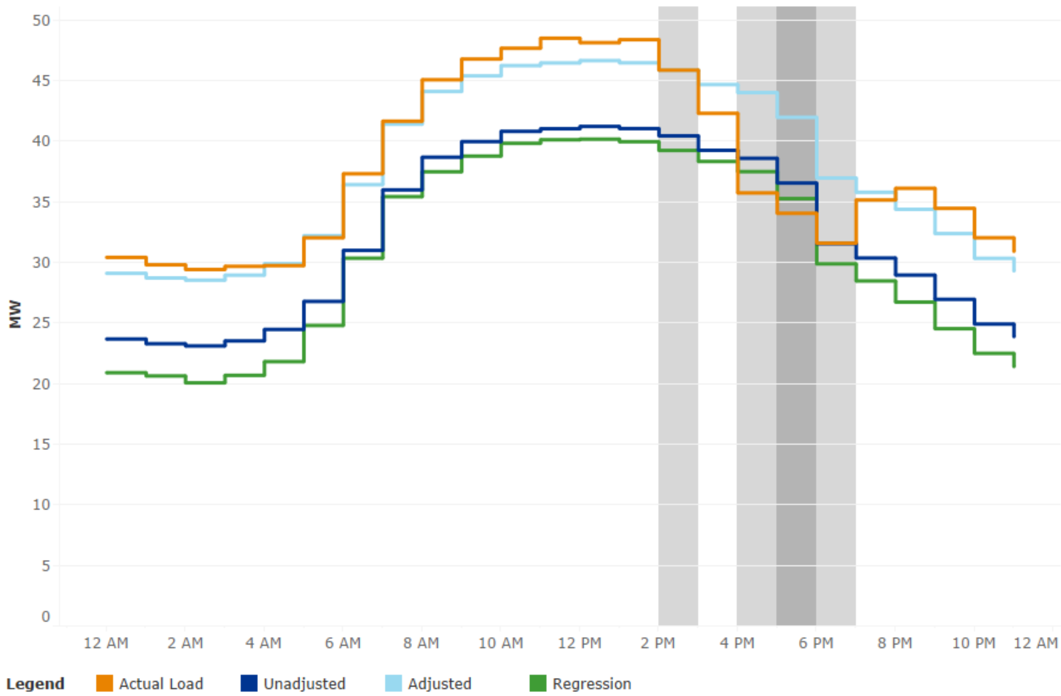


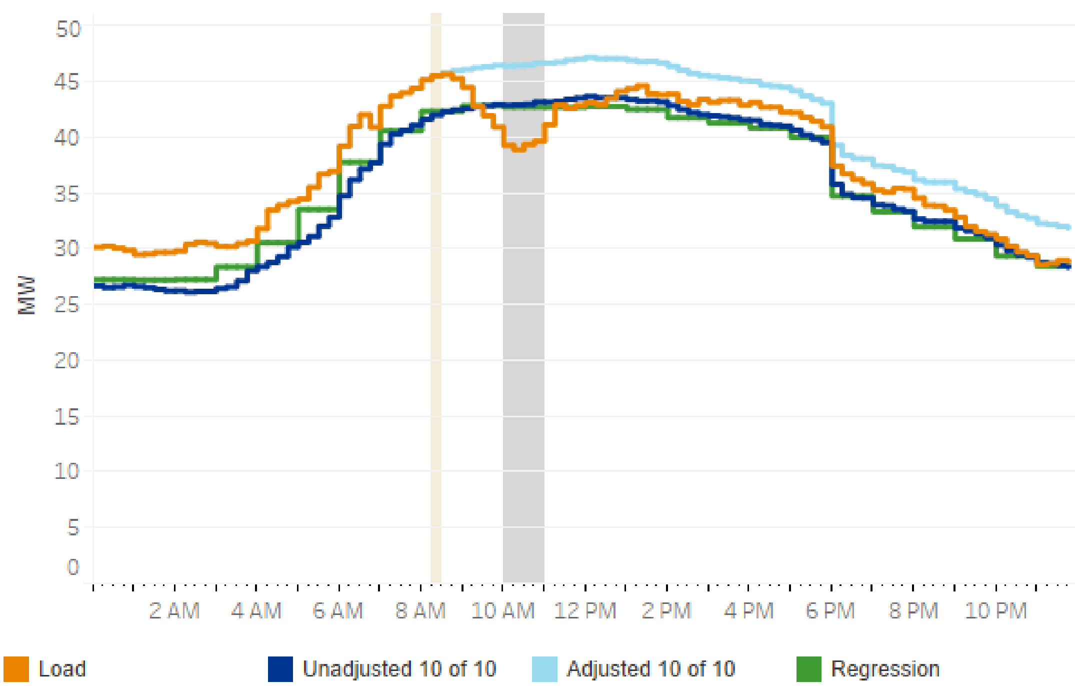
Table 5-11 summarizes the contracted, reported, and two evaluated load reduction estimates for the Winter LMP Test event. A test event was called because winter real-time ISO-NE LMP did not exceed the curtailment trigger (exceed $500 per MWh) during the season. The difference in reported and evaluated settlement results is due to incomplete data for some customers and suspected differences in the date and times of AMI data that were not explicitly time stamped (in this instance, Eastern Prevailing Time versus Eastern Standard Time). The difference between the regression and settlement baseline load reduction estimates is driven by one large account that does not appear to have curtailed load for the morning event. The settlement baseline shape contains an artificial ramp due to late starts on Mondays. The artificial ramp combined with the baseline adjustment produces a substantial load reduction estimate, despite no evidence of load reduction activity. In contrast, the regression baseline underestimates load because this account had been operating at lower levels of activity most of the winter.

Table 5-11. Manual Curtailment Winter 2018-2019 Test Event Impact Summary

Demand Reduction	Load Reduction (kW)
Contracted	5,000
Reported Settlement Baseline	6,635
Evaluated Settlement Baseline	7,190
Evaluated Regression Baseline	3,400
Accounts	53

Figure 5-5 provides a visual representation of the one-hour Winter LMP Test Event that Eversource called on March 27, 2019, from 10 to 11 a.m. The graph shows actual load (orange line) and evaluated baselines for the event day. The vendor received event notification from Eversource at 8:30 a.m. The adjustment period (beige shading) for the unadjusted rolling 10 of 10 baseline (dark blue line) is 8:15 to 8:30 a.m., the first three full 5-minute intervals, prior to the reported same-day notification from Eversource. The event period is shaded gray. Prior to event notification, the unadjusted 10 of 10 and regression baselines tend to underestimate actual load. The settlement baseline is shifted upward to align with actual load during the adjustment period.

Figure 5-5. Winter 2018-2019 LMP Test Event



Net Energy Impacts

No net energy impacts were claimed or evaluated for this solution.

Customer Billed Monthly Peak Demand

No customer billed monthly peak demand reductions were claimed or evaluated for this solution.

5.4 BMS Controls Findings

5.4.1 BMS Controls Recruitment

Vendor 1's scope of work listed a goal of enrolling 18 customers by summer 2019 for a total of 5,500 kW. Vendor 2's scope of work listed a goal of enrolling five customers to provide a cumulative reduction of 1,100 kW by the 2019 summer season. However, both vendors struggled to recruit customers quickly in the inaugural year of the demand demonstration project, due to a number of factors:

- **Delayed start.** Both vendors had delayed starts. BMS Controls 1 was delayed due to delays in obtaining leads from Eversource AEs. Eversource AEs had to be trained and removed from storm duty before they could start providing leads. BMS Controls 2 was delayed due to delays in contracting with Eversource. Neither vendor had any active participants for the 2018 summer demonstration season. Both vendors had active participants in the 2019 summer season.
- **Internal approval processes.** The execution of BMS controls projects requires the consent and collaboration of multiple stakeholders at a site (executives, facility management, BMS contractors). Both vendors explained that involving and educating all key stakeholders was a time-consuming endeavor, and even when there was a consensus amongst decision makers, it took time for the project to be approved at multiple levels of management.
- **Data security concerns.** Both vendors' systems are intended to directly tie into the customer's Internet; some customers were uncomfortable with this from a data security standpoint.
- **Control/automation concerns.** When considering BMS controls projects, customers are often hesitant to allow an external entity to control their building systems. In many cases, this drove customers not to participate with either vendor.

Vendor 1's Recruitment Process

In addition to the late start and the other barriers mentioned above, Vendor 1's sales process took many months. It involved multiple touch-points with the participants – the first for the initial sales pitch, the second to present an analysis of customers' electric bills and potential savings, and others to conduct an audit to select measures to curtail and to present (again) to the decision makers.

Vendor 2's Recruitment Process

Vendor 2's recruitment process consists mostly of customer engagement and technical due diligence. Unlike Vendor 1, most of Vendor 2's customer data collection begins after a customer has signed an agreement. The recruitment process begins when the vendor's sales team meets with as many relevant internal decision makers as possible at a prospective customer's facility. If the customer is interested in the solution, the sales team collaborates with the appropriate stakeholders at the site to evaluate the existing conditions of the BMS. Vendor 2's technology requires BACnet open protocol data. If the BMS is not already BACnet-enabled[6], the customer would have to invest in system improvements (e.g., exposing BACnet points in a system that is BACnet capable but not yet enabled, translate a legacy system to be BACnet-enabled).

5.4.2 BMS Controls Delivery

This section discusses the installation and project delivery (i.e., actual project implementation processes) of both vendors, including overarching insights and lessons learned by the Eversource PM that are applicable to both vendors.

Vendor 1's Installation

Once a customer has signed up to participate with Vendor 1, there are a few steps to get to an operational system. Though less invasive than a capital project, there is still equipment to install. In addition to the pulse meter installed by Eversource, Vendor 1 would also install a pulse meter, and then an electrician installs Vendor 1's relay device on to the vendor's pulse meter. The customer's BMS contractor then takes the sequence of operations and programs the script into the BMS; there may be iterations of programming to get the response just right.

The only challenge reported during the interviews for the delivery phase of the project regarded interactions with the BMS contractors (which can often affect the pre-agreement stage of recruitment as well). The customer's existing BMS contractor must be involved in the process, especially as they are the ones programming the sequence of operations into the BMS. They do not have an incentive to help the vendor and must put together a proposal for the additional effort and have it approved by the customer before slotting the project into their workload.

Vendor 2's Installation

As mentioned above, Vendor 2 conducts most of its customer discovery and data collection after the customer has signed an agreement and during the installation process (as opposed to Vendor 1, who does relatively in-depth site assessments during recruitment and prior to contract signing). This involves installing their proprietary technology at the site as well as discussions with the customer, a process which requires the following steps:

- **Tech install.** The vendor's integration team connects a small computer to the site's BMS network and internet, which will be used to send information to and from the vendor's servers.

[6] BACnet is a data communication protocol that governs the exchange of data over a network for building management systems.

- **Customer meeting.** After the analysis begins, the vendor meets with the customer to collect information about the building equipment and operations. The vendor also collects one year of historical meter data.

The vendor reviews the information they've collected from the BMS and from the customer and puts together a detailed M&V plan that explains how they determine baseline usage.

The two participants had high network security, which caused lengthy implementation processes. Due to the increased focus on resolving security and connectivity issues, the vendor was less focused than usual on interfacing with facility management personnel and learning about the building systems at the site. This resulted in them failing to uncover the fact that the BMS did not have the necessary HVAC control capabilities to implement the solution. The Eversource PM was surprised and dismayed that the vendor did not discover the lack of visibility into the BMS at Site 2 earlier in the implementation process.

Delivery – Vendor 1

Once the control system is operational, it will monitor the customer's usage and trigger the BMS to enact the sequence of operations when the set load threshold is reached.[7] The customer receives an email alerting them when the system is curtailing usage. There may be multiple levels for this strategy – i.e., a smaller reduction triggered when a lower threshold is reached, and a more drastic reduction when usage reaches a second higher threshold. There is another trigger as well, for potential ICAP peak hour forecasting. Here, the vendor has an algorithm that predicts when an ICAP hour might occur and triggers a reduction accordingly. However, Vendor 1 did not accurately forecast the 2019 ICAP hour and as such did not signal their demonstration participants to reduce load during the ICAP hour. The vendor PM later told the evaluation team that they had identified the cause of their forecasting miss; neither of the data sources their system had been programmed to reference on the morning of July 30 predicted that a system peak would be set that day. Additionally, the team found an error in their notification logic, in that their forecasting system was not notifying them when the day's forecasted peak was below but within a certain range of the previously set peak. The vendor PM reported that these issues have since been corrected.

[7] For customers with a manual sequence of operations, the device could instead trigger alerts in the form of lights or horns, or possibly email.

In addition to their demand management and energy reduction services, Vendor 1 also has a "managed services" offering that was available (for a cost) to their demonstration participants. With this service, a member of the vendor's engineering team meets (on-site and/or virtually) with facilities managers approximately once a month to walk through the data on their customer platform and help them understand their event performance and savings. They also discuss further opportunities for behavior modifications, adjust demand reduction targets if necessary, and point out potential issues in facility operations. In a discussion with the evaluation team following the summer 2019 season, the vendor PM explained that the managed services not only helped customers see the value their services were bringing but motivated them to do whatever was in their control to improve performance during future events. As a result of their demonstration experience, the vendor has decided to include their managed services in their core offering (i.e., not as an add-on for additional cost) to all their customers.

> The vendor PM explained that their "managed services" becomes a value add for customers, noting, "If you walk through the data with the customer, there's a lot of 'a-ha' moments, and that really tends to drive a lot of savings."

In the context of the demonstration project, Eversource paid for the managed services for three of the vendor's sites. The Eversource PM was interested to know whether the managed services made a difference in customer performance and was dissatisfied that the vendor did not include those details in their final report.

Delivery – Vendor 2

The delivery of active demand reduction for Vendor 2 is still not entirely clear since they did not successfully implement and demonstrate demand reductions at their single installed site. The following factors were primarily responsible for the lack of ability to measure the effect of their solution:

1. The building where they were implementing the project is part of a cluster of buildings with only one master Eversource meter; the building itself doesn't have a (sub)meter. Therefore, it is hard to understand impact of the technology on the building specifically.
2. The solution was intended to reduce load on the chiller plant serving the building. The chiller plant serving the targeted building is located in a different building and is served by a separate electric meter. The chiller plant power draw was not metered.

These were major issues, because without the necessary chiller plant metering and submetering of the affected building in place, the vendor was unable to demonstrate how their technology was reducing peak demand. The Eversource PM recounted asking the vendor multiple times to install meters both at the targeted building and at the chilled water plant. The vendor did not install either of those meters.

The Eversource PM expressed dissatisfaction with both vendors, as neither had achieved the goals established in their Statements of Work (SOWs). The primary objective of the demonstration project, as stated in both vendors' SOW, was to "test the capabilities of software and controls to provide load monitoring and management of building systems to reduce peak load." While the customer billed monthly peak demand and ICAP hour were expected to be the primary performance metrics, neither vendor succeeded in delivering expected reductions.

5.4.3 BMS Controls Customer Experience

Vendor 1

The evaluation team sent participant surveys to Vendor 1's eight participants and received four responses. Participants were asked to rate their satisfaction with various project components on a scale of 1 to 5, with 1 being "very dissatisfied" and 5 being "very satisfied." Results are shown in Table 5-12, below.

Table 5-12. Customer Satisfaction Ratings (Out of 5) – BMS Controls 1

Program Component	Score (N=8, n=4)
Information on technology	4.0
Information on cost savings	3.5
Vendor's technology/solution	3.3
Interactions with vendor	4.0
Demand/energy reduction	3.3
Cost savings/financial benefits	3.0
Eversource's involvement	3.0
Overall project	3.0

N – Total number of participants

n – Number of participants who responded to the customer satisfaction survey

Participants were highly satisfied with the information they were provided about the vendor's technology/DR solution and their interactions with the vendor and gave these project components a rating of 4 out of 5. Participants were comparatively less satisfied with the demand/energy reductions and cost savings or financial benefits provided by the projects, giving these project components an average rating of 3.3 and 3, respectively. Participants gave the overall project an average rating of 3 out of 5.

Vendor 2

The evaluation team reached out to both of Vendor 2's recruited participants and conducted a phone survey with Site 1's site contact (a representative from Site 2 refused the invitation for an interview). The participant was asked to rate their satisfaction with various project components on a scale of 1 to 5, with 1 being “very dissatisfied” and 5 being “very satisfied.” Results are shown in Table 5-13.

Table 5-13. Customer Satisfaction Ratings (Out of 5) – BMS Controls 2

Program Component	Score (N=2, n=1)
Information on technology	3
Information on cost savings	3
Vendor's technology/solution	4
Interactions with vendor	3
Demand/energy reduction	3
Cost savings/financial benefits	3
Eversource's involvement	5
Overall project	3

N – Total number of participants

n – Number of participants who responded to the customer satisfaction survey

The participant was highly satisfied with Eversource’s involvement (gave a rating of 5 out of 5), stating that his AE was very helpful. Additionally, the participant rated the vendor’s technology with a 4 out of 5 as he was able to see on an ad-hoc basis that site energy usage was going down, and he attributed that reduction in consumption to the demonstration project.

The participant rated all other project components with a 3 out of 5 and gave explanations for his neutral ratings. The participant reported having a seamless technology installation process and was impressed with the vendor’s reliability in communicating when they would be making changes to setpoints. However, the participant was disappointed to learn that the vendor was missing metering on the HVAC equipment at the building or at the chiller plant necessary to demonstrate the magnitude of kWh savings they had achieved. Despite receiving savings reports and meeting with a representative on the vendor’s engineering team on a monthly basis to discuss achieved savings, the participant commented that the vendor has not been able to demonstrate that their technology is responsible for the kWh and kW savings they’ve shown in their reports.

5.4.4 BMS Controls Performance

There were two vendors providing BMS software solution demonstration projects during the summer of 2019. Triggers for curtailment were initiated by the vendors and were customer specific (i.e., they were not initiated by Eversource). Vendor 1 had 8 customers signed up for the summer season. This demonstration utilized controls to reduce a facility’s energy use and monthly peak demand by adjusting various building system operations. Peak load reductions for this demonstration were quantified using a rolling, meter before-meter after (MBMA) baseline and a regression baseline. Vendor 2 had one participant in the 2019 summer season. The demand response feature of this solution was not activated in the 2019 season, though they indicated a focus on energy savings (kWh) with permanent demand savings was pursued as a "side benefit."

Vendor 1 had 8 participating sites, though only 7 had vendor-provided results and three of them had demand reduction measures rarely, or never, activated. The four sites shown in Table 5-14 are those where monthly peak demand activations were able to be analyzed. The MBMA results show no meaningful load impacts for sites 1 and 3. The negative load reductions in the regression results can be considered evidence of either no load reduction or they may provide evidence of the downward bias of the regression estimates of high load hours. With that in mind, there is tentative favorable evidence for modest BMS controls-related bill demand reductions in some months for sites 2 and 5.

Table 5-14. BMS Controls 1 Evaluated Monthly Billed Peak Demand Reduction

Average Billed Monthly Peak Reduction				
Site	Billed Demand Units	Reported	MBMA	Regression
Site 1	kVA	217	-5	-321
Site 2	kVA	87	24	-38
Site 3	kW	232	-3	-339
Site 5	kW	130	12	-40

Vendor 2 is believed to have achieved very small to negligible demand reductions for the targeted building. Unfortunately, due to a lack of metering of the affected building and affected chilled water system, accurate reductions could not be quantified, though the vendor indicated they can configure the product to provide demand response in future trials and deployments if desired.

Net Energy Impacts

BMS Controls 1 did claim energy savings, however, for a majority of sites, there is no way to attribute the energy savings to the installed solution. The evaluators attempted to do a regression analysis to calculate these savings; however, the regression models were unable to reliably estimate load or distinguish between BMS and non-BMS changes that occurred at the sites around the time of implementation. The regression results for the evaluation of BMS Control 1 monthly billed peak demand reduction may provide evidence of downward bias of regression estimates during high load hours.

6 Evaluation Conclusions and Recommendations

The evaluation team has identified nine key findings:

1. **Event performance varied by technology solution:**
    a. ***Targeted Battery and Manual Curtailment.*** Both solutions performed reliably and in accordance with their scopes of work and goals. The evaluated impacts for the targeted battery and manual curtailment demonstrations matched the vendor-reported impacts.
    b. ***BMS Controls.*** The software BMS control solutions did not provide a verifiable reduction of customer monthly peaks or summer system peak loads. Both BMS control offerings appear to have opportunities for optimization that might produce impacts verifiable through a combination of engineering and load analysis in future seasons.
    c. ***Thermal Storage 1.*** Thermal Storage 1 was successful in offsetting the rooftop unit (RTU) cooling load during the dispatch window; however, a majority of the RTUs selected for control were oversized and underutilized, resulting in low demand reduction. While this does not reflect the lack of ability or potential for the technology, it does mean demand response (DR) for demonstration participants was lower than committed. This vendor did not revise predicted demand reductions based on actual summer performance.
    d. ***Thermal Storage 2.*** Thermal Storage 2 was reliable and successful in shedding load during the dispatch window. The lower-than-reported demand reductions are entirely due to differences in the calculation methodology between the vendor and the evaluators. The vendor used a calculation methodology that systematically overstated reductions.
2. **System peak hour reduction.** The total evaluated demand reduction at the system peak hour (July 30, 2019, 5-6 p.m.) was 8,685 kW. The manual curtailment demonstration represented 91% of system peak impacts and 38% of participating customers.
3. **Winter event performance.** The 2018-2019 winter season did not have any high locational marginal pricing (LMP)-triggered events. A test event was conducted for the manual curtailment and targeted battery solutions near the end of the season. Both solutions performed as expected during the test event.
4. **Net energy impacts.** Thermal Storage 2 resulted in energy savings of 126,420 kWh during the 2019 summer season. Targeted batteries resulted in a net energy increase of 2,520 kWh during the 2019 summer season at an average seasonal efficiency of 66.1%.

Manual Curtailment and Thermal Storage 1 were not expected or evaluated to have energy savings. There may be energy savings from the BMS Controls solutions, but these impacts were not a primary objective of this demonstration and were not quantified.

5. **Recruiting.** A mix of recruiting approaches were employed for these projects, ranging from almost entirely vendor-driven to almost entirely account executive (AE)-driven. AEs were able to provide valuable leads and help with customer introductions but were not consistently available to help with customer follow-up due to competing responsibilities, such as other programs and customer support during winter storms. Vendors who took control of customer education and relationship-building during the second year of the demonstration project and had more success in recruiting.
6. **Delivery.** Six of the seven vendors experienced delays in implementation. The exception was the vendor with several customers already participating in ISO-NE forward capacity market (FCM) offerings through a mature manual curtailment program. The combination of newer DR technologies such as energy storage and newer vendors in the New England market exacerbated new program administrative challenges and delayed roll-out compared to expectations. The slower ramp-up does not indicate flaws in the solutions but does indicate that trial periods are necessary to work out complexities prior to full-scale deployment of newer solutions.
7. **Customer satisfaction.** Overall, customers participating with manual curtailment and thermal storage solutions were satisfied with the projects with average scores of 4.0, 4.3, and 3.7 out of 5. The BMS Controls and Targeted Battery customers rated their project satisfaction at 3 out of 5, indicating that while they were not dissatisfied with the projects, there is room for improvement.
8. **Storage technology education.** The energy storage (thermal and battery) market is nascent in Massachusetts and requires significant customer education. For thermal storage projects in particular, the demonstration facility proved valuable to showcase to other customers.
9. **Customer screening process.** The initial customer screening process was too lenient for the thermal storage solutions and BMS controls solutions, leading to failed applications at the time of installation, lower impact for the thermal storage vendors, and longer-than-anticipated installation processes for the BMS controls vendors.

The evaluation team identified opportunities for improvement that were unique to individual vendors or their technologies and provided them in separate technology-specific reports. The recommendations presented below are cross-cutting and apply generally or at least to multiple vendors. Since the demonstration projects have largely concluded, the recommendations address issues that are either meaningful to Eversource's full-scale active demand response (ADR) initiative that launched in 2019 or applicable to other Eversource programs. They are categorized below into program-design-oriented recommendations and evaluation-oriented recommendations.

Program-Design-Oriented Recommendations

- Recommendation #1: **Provide feedback to vendors on calculation shortcomings.** Several vendor impact calculations the team examined have opportunities for improvement moving forward. These included average daily dispatch reductions for Thermal Storage 2, billed monthly peak demand reductions for targeted batteries, and billed monthly peak demand reductions and energy savings for BMS Controls 1.
- Recommendation #2: **Collect sufficient data to ensure project feasibility early in the participation process.** Data collection during the early stages of project development should be more thorough to ensure project feasibility. For example, Thermal Storage 1 had multiple instances where engaged customers began to do a lot of groundwork only to find out the solution was either incompatible with their RTUs or was not feasible due to spatial or installation constraints. During the screening site visit, the vendor should verify that the preexisting RTUs have sufficient space for an additional cooling coil, confirm that the proposed location of the solution would be feasible for installation, and perform enough building cooling load or billing analysis to be confident that the affected space will call for near-capacity cooling output during dispatch hours. Similarly, Thermal Storage 2 had customers who were unable to participate because old refrigeration compressors were in poor condition. BMS Controls 2 also had a site that was delayed significantly when the vendor learned the site's BMS functionality did not have the necessary points of control.
- Recommendation #3: **Vet M&V plans.** Vendor M&V plans did not always contain sufficient detail on how vendors would quantify demonstration performance metrics. In particular, the two BMS solutions were not able to be fully evaluated due, in part, to a lack of detail on M&V requirements and methods. While the demonstration projects were not pay-for-performance (P4P) offerings, the full-scale program is a P4P program. For a pay-for-performance program, being able to quantify performance in a defensible manner would be particularly important.
- Recommendation #4: **Require clear, quantifiable goals and performance metrics, and standardize reporting of DR strategies and delivered performance.** Require vendors to provide site-specific DR strategies, performance goals, and delivered performance in a standardized manner.

- **Recommendation #5: Require local presence of vendor marketers or plan longer ramp-up periods.** The evaluation team found that out-of-state vendors without a local marketing presence generally had a more difficult time recruiting and longer ramp-up periods than those with staff dedicated to demonstration recruitment in Massachusetts. While not a fix-all, having a local marketing representative responsible for sharing customer education and rapport-building efforts with utility AEs is expected to accelerate customer recruitment.

Evaluation-Oriented Recommendations

- **Recommendation #6: Involve M&V contractor during DR feasibility testing to allow for real-time verification of manual curtailment and BMS controls projects**. In order to prevent customer fatigue, and to allow for an easier evaluation of the implemented projects, the BMS controls and manual curtailment project vendors should include the evaluation team in the feasibility testing phase of the projects. This will allow evaluators to understand the equipment operation and load reduction through the test, rather than having to conduct an additional site visit for the same purpose.